THE USE OF ULTRASOUND ESTIMATED BLADDER WEIGHT IN

DIAGNOSING BLADDER OUTLET OBSTRUCTION

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

in partial fulfillment of the requirements for the award of the degree of

M.Ch (UROLOGY) – BRANCH – IV

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI

AUGUST 2011

DECLARATION

I solemnly declare that this dissertation titled THE USE OF ULTRASOUND ESTIMATED BLADDER WEIGHT IN DIAGNOSING BLADDER OUTLET OBSTRUCTION was prepared by me in the Department of Urology, Rajiv Gandhi Government General Hospital, Chennai under the guidance and supervision of Prof. R. Jeyaraman, M.Ch ., Professor & Head of the Department, Department of urology, Rajiv Gandhi Government General Hospital, Chennai. This dissertation is submitted to The Tamil Nadu Dr. MGR Medical University, Chennai in partial fulfillment of the university requirements for the award of the degree of M.Ch. Urology.

Place: Chennai

Date: DR.S.SENTHIL KUMAR

CERTIFICATE

This is to certify that the dissertation titled “The use of ultrasound estimated bladder weight in diagnosing bladder outlet obstruction” submitted by **Dr.S.SENTHIL KUMAR** appearing for **M.Ch. (Urology)** degree examination in August 2011, is a bonafide record of work done by him under my guidance and supervision in fulfillment of requirement of The Tamil Nadu Dr.M.G.R.Medical University, Chennai. I forward this to The Tamil Nadu Dr.M.G.R.Medical University, Chennai.

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ACKNOWLEDGEMENT

First of all, I would like to thank my patients, who subjected themselves for my dissertation work.

I whole heartedly thank **The Dean**, Madras Medical College and **Medical superintendent**, Rajiv Gandhi Government General Hospital, Chennai for allowing me to avail the facilities needed for my dissertation work.

I would like to express my humble gratitude to **Prof. R.Jeyaraman**, M.Ch, Professor and Head of the Department of Urology for his expert guidance and help rendered for the conduct and completion of my dissertation work.

I would like to thankfully acknowledge **Prof.V.Kamaraj** and **Prof. RM. Meyyappan**, Professors in the Department of Urology, for their constant help in carrying out my dissertation work.

I sincerely thank The Director & Superintendent **Dr.K.Thiyagarajan**, Mch, Institute of non communicable diseases, Government Royapettah Hospital for his help in completing my dissertation.

I sincerely thank the Asst professors in the Department of Urology for their continuous inspiration and support in carrying out my dissertation.

Last, but not least, I thank my fellow past and present postgraduates who helped me in carrying out my work and preparing this manual.

DISSERTATION

INTRODUCTION

Lower urinary tract symptoms (LUTS) have an increasing prevalence in ageing men and women. Men who present with LUTS are investigated for benign prostatic enlargement (BPE) and bladder outlet obstruction (BOO), both of which are usually the result of benign prostatic hyperplasia (BPH). [1] Bladder outlet obstruction is the generic term for obstruction during voiding and is characterized by increased detrusor pressure and reduced urinary flow rate.

However, LUTS alone are not sufficient in diagnosing benign prostatic enlargement or bladder outlet obstruction and other investigations are usually required. [2] In patients with BPH, no strict relationship between LUTS, BPE, and BOO has been found so far.

Uroflowmetry is a economic test which provides some information on the voiding function and is easy to perform in the outpatient setting. However, it lacks the required specificity as it is unable to differentiate between bladder outlet obstruction and detrusor underactivity. Conversely, pressure-flow studies remain the reference gold standard test in diagnosing bladder outlet obstruction as they are able to provide valuable information on the detrusor contractility as well as the presence or absence of obstruction. This, unfortunately, does not come easily as urodynamics are invasive tests and require specialist equipment and training to perform the tests and interpret the results. [3] . Thus, a noninvasive, quick, inexpensive and easily available diagnostic tool with a high sensitivity and specificity for determining bladder outlet obstruction would be ideal .The quest for a non-invasive test diagnostic of bladder outlet obstruction has been ongoing for many years. Many parameters were investigated including free uroflowmetry, post-void residual volume and quantification of prostate volume.[4] Over the past decade , interest into bladder wall thickness [BWT]and consequently bladder wall weight has grown rapidly. In a recently published meta-analysis of all available noninvasive tests for bladder outlet obstruction evaluation, ultrasound measurements of bladder wall thickness and bladder weight were the only promising methods with a good evidence base to support their use in entering clinical practice after further evaluation. This was based on the rationale that bladder outlet obstruction is associated with detrusor hypertrophy and an increase in bladder wall thickness. In fact, morphological studies showed that the increase in bladder wall thickness was the result of smooth muscle hypertrophy as well as increased collagen deposition in the bladder wall.[5] we estimated the diagnostic accuracy of ultrasound bladder wall thickness and bladder weight measurement for bladder outlet obstruction and investigated whether this method can replace pressure flow studies [PFS] in diagnosing bladder outlet obstruction.

Therefore, the aim of our study is to prospectively evaluate the diagnostic accuracy of ultrasound estimated bladder weight [UEBW] in patients with clinical BPH and history of obstructive LUTS to diagnose bladder outlet obstruction as defined by pressure–flow analysis(reference standard).we also studied the relevance of Bladder wall thickness[BWT] measurements, International prostate symptom score [IPSS], uroflowmetry, postvoid residual urine[PVR], and prostate volume (index tests) in our patients with clinical BPH and history of obstructive LUTS to diagnose bladder outlet obstruction as defined by pressure–flow analysis(reference standard).

AIM AND OBJECTIVE

The aim of this study is

1) To study the use of ultrasound estimated bladder weight in diagnosing bladder outlet obstruction in men with benign prostatic enlargement and obstructive lower urinary tract symptoms.

REVIEW OF LITERATURE

Benign prostatic hyperplasia and other disorders can cause mechanical bladder outlet obstruction. Such an outlet obstruction can in turn cause hypertrophy of the bladder detrusor muscle, which may lead to additional irritative urinary symptoms. Such a hypertrophy manifests as increased detrusor wall thickness and an increased bladder weight. A recently published article, which reviewed the morphologic and functional changes of the bladder wall in response to bladder outlet obstruction, describes comprehensively how mechanical stretch induces gene expression and protein synthesis in the epithelium and smooth muscle cells, and explains how bladder outlet obstruction could cause lower urinary tract symptoms

Ultrasound emerged as the easiest and least invasive option in measuring bladder wall thickness. The bladder wall appears on ultrasound as a three layer structure with the detrusor muscle represented by a hypoechogenic layer between two hyperechogenic layers representing the serosa and mucosa .[6] Some investigators measured the thickness of the three layers together,[7] whilst others used the middle detrusor layer only.[8] Most studies used the anterior bladder wall by transabdominal ultrasound, however, some used the posterior bladder wall by transrectal or transvaginal ultrasound .[9] Studies have shown that there are no significant differences in the thickness of either anterior or posterior wall of the bladder .[10,11]

Ultrasound imaging depends on the frequency of the ultrasound waves used; the higher the frequency, the better the resolution of the image but lower the depth of penetration.[12] Oelke et al. suggested that it is necessary to use high-frequency ultrasound arrays (7.5 MHz or higher) with an enlargement function of the ultrasound picture for precise measurement of bladder wall thickness (BWT).[8] The problem with bladder wall thickness is that it is volume dependent; wall thickness decrease with increasing filling volume. Oelke et al. studied 9 volunteers with normal urodynamics and found that bladder wall thickness decreased rapidly during the first 250 ml of bladder filling.[8] This prompted others to investigate bladder wall weight as a measure of bladder hypertrophy which should remain constant at different bladder volumes.[10] Again for measuring bladder wall thickness,both two dimensional B-mode and three dimensional V-mode ultrasound can be used, each having its own merits and demerits.

.Adequate noninvasive methods for diagnosing these conditions do not exist and, thus, pressure volume studies of filling and pressure flow studies of voiding remain the gold standard investigations. However, these tests are invasive, expensive and time-consuming with associated morbidity.[13] Animal studies have revealed bladder wall hypertrophy and increased bladder weight after partially induced bladder outlet obstruction,[14-18] within as little as 2 weeks.[5] Mean bladder wall thickness in control, partially obstructed and severely obstructed rabbits was 1.57, 2.04 and 2.77 mm, respectively, with most thickening in the detrusor layer.[15] Histological analysis showed smooth muscle cell hypertrophy and hyperplasia, and increased collagen deposition, ratio of type I-to-III collagen [15,18] and muscarinic cholinergic receptors.[16] Similar histological patterns were observed in patients with bladder outlet obstruction [19,20] and detrusor overactivity [DO] [21], and in those undergoing augmentation surgery for high intravesical pressure. [22] Furthermore,bladder weight, smooth muscle cell hypertrophy and collagen deposition have been shown to partially reverse after BOO relief in pigs.[17] Beamon et al demonstrated concurrent development of detrusor hypertrophy and detrusor overactivity with induced BOO in mice at 6 weeks, which is a well-known association in clinical practice.[18] .Historically urologists believed bladder trabeculation to be a marker of bladder outlet obstruction. Although studies have confirmed this relationship, [19,23] in some cases detrusor overactivity and not bladder outlet obstruction may be the causative factor.[24] Bladder wall hypertrophy can be visualized on ultrasound. Ultrasonic measurements of bladder wall thickness and bladder weight can distinguish between obstructed and nonobstructed rabbit bladders.[25] In the last decade increasing interest has arisen in the measurement of bladder wall thickness and the ultrasound estimation of bladder weight as a noninvasive means of assessing lower urinary tract symptoms. However, to date such measurements have not been adopted into clinical practice

BWT/DWT in Healthy Asymptomatic Adults

Before ultrasound measurement of BWT/DWT can be used as a reliable clinical tool, the quantification of these measurements in the healthy,asymptomatic population must be established. However, reports on normal measurements are few and difficult to compare because of fundamental differences among them, particularly for BWT or DWT and the degree of bladder filling at which such measurements should be taken. On transabdominal ultrasound (TAUS) at a variety of filling volumes in asymptomatic healthy volunteers mean bladder wall thickness [BWT] was 3.33 and 3.04 mm in 172 men and 166 women, respectively.[26] This gender difference was also observed in measurement of the detrusor layer in 55 healthy volunteers, with a mean DWT of 1.4 and 1.2 mm in males and females, respectively, measured at a bladder volume of 250 ml or greater [8] Measurement of DWT was considered preferable to total bladder wall thickness for two reasons. 1) Previous animal studies have shown the muscle layer to be mostly affected by pressure changes and 2) the mucosa could be influenced by other bladder pathology such as carcinoma or infection. In both studies wall thickness was measured at a variety of filling volumes. Although both revealed a decrease in wall thickness with increasing filling volume, only the later study [8] quantified this at incremental measurements in the same individual. [8] DWT decreased at volumes up to 250 ml but beyond that point it remained relatively static. The authors recommend measuring DWT at a filling volume of 250 ml or greater when possible. Another study of asymptomatic healthy volunteers revealed a slightly higher mean DWT of 2mm. [28] As only a single measurement was taken in each patient at a filling volume of 200 ml, these results may reflect an underestimation of DWT. [8] Furthermore, images were inadequately enlarged to obtain an accurate measurement and some of the patients were pretreated with alpha blockers known to decrease

BWT/DWT. In conclusion, there is no consensus in the literature for age and gender specific diagnostic ranges or cut offs for BWT/DWT.

BWT or DWT in bladder outlet obstruction [BOO]

A handful of studies have attempted to quantify the diagnostic ability of transabdominal ultrasound measurements of BWT/DWT in patients with suspected bladder outlet obstruction. Hakenberg et al reported a mean bladder wall thickness of 3.67 mm in 150 men with LUTS at a variety of filling volumes. [26] However, no statistically significant difference was found between these men and age matched asymptomatic controls. In another study a similar mean of 4mm was obtained in 170 men with urodynamically confirmed bladder outlet obstruction [7] . BWT was measured at a single filling volume of 150 ml. A value of 5 mm appeared to be the best cut off to diagnose BOO, with 88% of patients with BWT 5 mm or greater confirmed as obstructed on pressure flow studies [PFS].Based on preliminary data revealing an effect of filling volume on DWT in healthy volunteers, Oelke et al assessed DWT at bladder capacity in men with bladder outlet obstruction [28] .DWT increased incrementally in relation to the degree of obstruction. On pressure flow studies, mean DWT was 1.33, 1.62, 2.4 and greater than 3 mm in unobstructed, equivocal, obstructed and severely obstructed patients, respectively. Comparable results were reported in a similar study of DWT at filling capacity in 102 men with LUTS.[29] Median DWT was 1.7, 1.8 and 2.7 mm in the unobstructed, equivocal and obstructed groups, respectively, with a DWT of 2.9 mm or greater shown to be the best cutoff to diagnose bladder outlet obstruction (positive predictive value 100%, specificity 100%, area under the curve [AUC] 0.88). In both of these studies the difference in DWT between unobstructed and obstructed patients was statistically significant.

More recently a DWT of 2 mm or greater was reported in 94% of men with bladder outlet obstruction confirmed on pressure flow studies at a filling volume of 250 ml or greater. [4] Compared to other clinical parameters DWT was the best test to predict BOO with an area under the curve AUC of 0.93. In addition, adjusting the DWT threshold to 2.5 mm, as reported by Kessler et al, [29] revealed similar sensitivity and specificity to that reported by Oelke et al.[28,4] More recently, a study of 155 Turkish men reported a statistical difference in BWT in those with a maximum uroflow rate of 10 ml per second or less (mean BWT 4.44 +/_ 1.18 mm) compared to those with a rate greater than 10 ml per second (mean BWT 3.85+/ _0.76 mm). [30] Measurements were taken at bladder volumes between 150 and 200 ml. Although a consistent trend between

BWT / DWT and bladder outlet obstruction can be appreciated, no definitive reference ranges have been established.

Ultrasound Estimated Bladder Weight

BWT/DWT is affected by filling volume. Therefore, its usefulness as a clinical tool becomes limited in everyday practice. Kojima et al attempted to resolve

this problem by calculating bladder weight.[10] Transabdominal ultrasound measurements of intravesical volume and BWT were obtained. Assuming the bladder to be a sphere, the bladder wall volume was calculated by subtracting

the intravesical volume from the total bladder volume, which includes the bladder wall. The ultrasound estimated bladder weight [UEBW] was obtained by multiplying this parameter with the specific gravity. The UEBW of 10 cadaveric bladders correlated significantly with the actual bladder weight

($r = 0.970$, $p < 0.0001$), and stable UEBW was observed in 16 patients measured repeatedly at filling volumes between 100 and 300 ml. Kojima et al also reported greater mean UEBW in conditions that cause BOO, such as benign prostatic hyperplasia, prostate cancer and urethral stricture. [31] Mean UEBW was significantly higher in 34 obstructed men (BOO index greater than 40,mean UEBW 46.2 gm) than in 31 unobstructed men(mean UEBW 29.3 gm). Receiver operator characteristic [ROC] analysis demonstrated an UEBW cutoff of greater than 35 gm for predicting BOO with 87.9% of obstructed men having an UEBW greater than 35 gm.

.Ochiai and Kojima correlated UEBW with ultrasonic measurement of prostatic size. [32] In 234 men a mean UEBW of 41.1 gm was observed in those with a larger prostate compared to 27.1 gm in those with a normal size prostate. A larger prostate and postvoid residual volume greater than 100 ml correlated with UEBW greater than 35 gm. In a longitudinal study of 33 men with benign prostatic hyperplasia mean UEBW decreased significantly from 52.9 to 35gm

4 weeks after prostatectomy compared to 26.5gm in control patients. [33] At 12 weeks mean UEBW was 31.6 gm and had completely normalized in the majority of men.

Miyashita et al studied UEBW in men with acute urinary retention [AUR]. [34] Of these men 90% had an UEBW of 35 gm or greater compared to only 41% of those without AUR. Multivariate analysis revealed age and UEBW to be significant determinants of AUR, and men with an UEBW greater than 35 gm were 13.4 times as likely to develop AUR. In a longitudinal study of men receiving tamsulosin for LUTS, UEBW was 35 gm or greater in approximately half. [35] At 5 years 81.7% of these men had undergone prostatectomy compared to only 36.2% of those with UEBW less than 35 gm. Multivariate analysis demonstrated UEBW 35 gm or greater and International Prostate Symptom Score 20 or greater to be significant risk factors for proceeding to surgery. Although UEBW appears to be an attractive assessment method for bladder outlet obstruction, its diagnostic power should not be overstated. To our knowledge there is currently no published literature from other institutions to confirm or dispute the findings of Kojima etal. [31]

UEBW Automation

One problem with the measurement technique used in all the above studies is that bladder weight is dependent on an experienced operator measuring bladder wall thickness and all the calculations have to be done manually. The development of a handheld device with automated measurement and calculation presented a great step forward. The BladderScan® BVM 6500 (Verathon Medical, Bothell, USA) acquires a V-mode ultrasound image using a 3.7 MHz transducer rotating within

120° cone.[36] The 3-dimensional ultrasound data is transferred into a computer to be analyzed using a specially developed algorithm that identifies the bladder region

The inner surface of the bladder is delineated on the 3D image by the computer and the bladder surface area (SA) is calculated by triangulation. The anterior bladder wall is determined and the thickness (BWT) is measured automatically. Ultrasound-estimated bladder weight is then calculated using the formula:

UEBW = BWT x SA x specific gravity

The stated advantages of automated measurement of ultrasound-estimated bladder weight are:

1. Use of 3D rather than 2D ultrasound
2. Calculation of the actual surface area rather than assuming a spherical bladder
3. Automated and reproducible measurement

Using data from 216 scans in 20 healthy male subjects, this approach estimated mean (SD) bladder weight to be 42 (6) g.[36] It is noted that this estimate is higher than that quoted by Kojima in normal subjects of 29.3 (9.4) g.[37] This is explained by the fact that a sphere has the least surface area for a given volume and since the bladder shape is almost never absolutely a sphere, the calculation using the true surface area would produce higher estimate of bladder weight. The variation in the repeated measure of automated bladder weight measurement corresponded with a coefficient of variation of 9%.

A further study reported a mean (SD) normal range for ultrasound-estimated bladder weight measured using the BladderScan® BVM 6500 of 47.8 (9.3) g in a population based group of 359 Caucasian men (age range 54-92 years) from Olmsted County, USA. The study concluded that bladder wall thickness and surface area were better correlated with symptom severity score, peak flow rate, prostate volume, and PVR when compared to manually calculated bladder weight. However, the group did not state clearly the volumes at which the scans were performed which would have a significant bearing on both bladder wall thickness and bladder surface area.[38]

The accuracy of existing methods to estimate bladder weight is limited because of the assumption that the bladder is spherical in shape. Our results have shown that the bladder is significantly nonspherical in shape. Also, because in the existing methods the thickness is measured manually, the bladder wall measurements suffer from high inter- and intra-observer variability.

The main benefit of this new approach is that it produces more accurate and consistent estimates of UEBW. The reasons for this include: 1) the use of 3D rather than 2D data to calculate bladder surface area and thickness, 2) the use of the true surface area instead of an assumed spherical surface area, and 3) the automatic and consistent measurements of wall thickness and surface area using advanced image processing algorithms. Additional benefits of this approach are its noninvasiveness and ease of use—UEBW is measured over a range of bladder volumes, thereby eliminating the need to catheterize the patient to fill up to a fixed volume. since 3D ultrasound is not available in our institution,we calculated bladder wall thickness with the available 2D B-mode ultrasound machine in our department.

MATERIALS AND METHODS

TITLE OF THE STUDY:

The use of ultrasound estimated bladder weight in diagnosing bladder outlet obstruction .

PERIOD OF STUDY:

January 2009 –April 2011

STUDY DESIGN:

Prospective study

PLACE OF STUDY:

The study was conducted in the Department of Urology, Rajiv Gandhi Government General Hospital , Madras Medical college, Chennai.

ETHICAL CLEARANCE:

The institutional ethical review board at our hospital approved the study.

INCLUSION CRITERIA:

1.Male patients above 50 years of age.

2.History of obstructive LUTS.

3.Patients should not be on foley catheter.

EXCLUSION CRITERIA:

1. Patients with other pathology like vesical calculus ,carcinoma bladder, and carcinoma prostate.

2. Patients with past history of bladder, prostate, and urethral surgeries.

3 .Patients with neurogenic bladder.

METHOD OF STUDY:

Informed consent obtained from all the patients after explaining details of the study.All details were recorded in a proforma as an outpatient procedure. Prospective analysis done with the collected details.

PATIENT EVALUATION:

All 120 patients who satisfied the above mentioned inclusion/ exclusion criteria were enrolled in this study. International prostate symptoms score recorded for each patients with specified questionnaire. All patient were subjected to transabdominal ultrasonography in full bladder using Siemens ultrasound machine to calculate bladder volume, prostate volume using ellipsoid formula with 7.5 Hz high frequency probe.

Anterior bladder wall imaged and freezed by magnification, anterior bladder wall thickness measured in centimeters and recorded. Then patients were subjected to uroflowmetry using status uroflowmeter, post void residual urine calculated using trans abdominal ultrasound. Bladder weight then calculated using above recorded parameters applying formulae of sphere.

Patients were then subjected to urodynamic evaluation to calculate detrusor pressure at Qmax . Abraham Griffith Number [AGN] / Bladder outlet obstruction index [BOOI]calculated by using the formula

BOOI/ AGN = Pdet Qmax – 2 Qmax

If >40 = Obstructed, <20 Non obstructed, 20-40 Equivocal.

Patients included in the study are divided into 2 groups based on Pressure flow studies into obstructed and non obstructed .Hence study group contains,

Group I: Nonobstructed [Bladder outlet obstruction index /Abraham Griffith Number ≤ 20]

Group II :obstructed [Bladder outlet obstruction index /Abraham Griffith Number ≥ 40]

The following steps are used to measure the UEBW:

1. Using the known filled intravesical volume, *Vi*, and assuming the bladder to be a sphere, first estimate the inner radius, *ri*, of the bladder as:

$$r_i = \sqrt{\frac{3V_i}{4\pi}}$$

2. Next, using the measured thickness, *t*, estimate the outer radius, *ro*, of the bladder shell as: *ro* = *ri* + *t*

3. Using the outer radius, estimate the total vesical volume, *Vo*, as:

$$Vo = \frac{4}{3} \pi r_0^3$$

4. Finally, estimate UEBW by calculating the bladder muscle volume as the difference between the total vesical volume and the intravesical volume and multiplying this bladder muscle volume with the specific gravity, p, of the

bladder muscle tissue:*UEBW* = (*Vo*–*Vi*)p

All the above recorded individual parameters were compared and analyzed against ultrasound estimated bladder weight in both obstructed and non obstructed groups for diagnosing bladder outlet obstruction.

STUDY ANALYSIS:

The Statistical Package for the Social Sciences, version 18.0.2 (SPSS Inc, Chicago, IL, USA) was used for the statistical analysis.

A p value equal to or below 0.05 was considered significant. Positive and

negative predictive values, sensitivity, specificity,diagnostic accuracy, and the likelihood ratio of a positive or negative test result were calculated for DWT, Qmax, , postvoid residual urine, and prostate volume. Receiver operator characteristic (ROC) curves were produced to visualize, and calculation of the area under the curve (AUC) was used to describe the diagnostic characteristics of the index tests to diagnose bladder outlet obstruction.

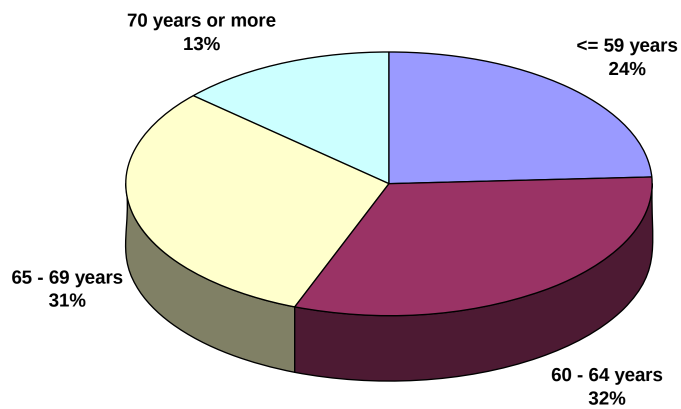
OBSERVATION & RESULTS

Descriptive Statistics

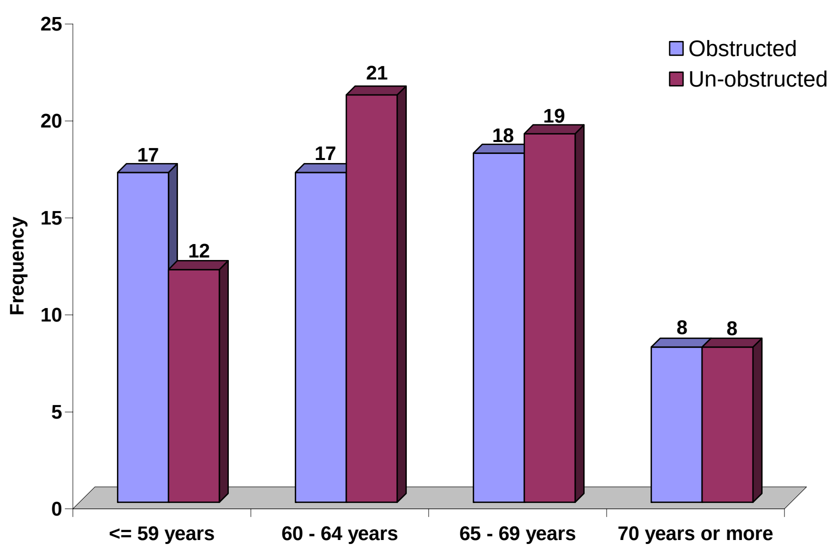
Combined	Number	Minimum	Maximum	Mean	Std. Dev	Variance
Age in years	120	52.0	73.0	63.675	4.9691	24.692
International Prostate symptom score	120	5.0	26.0	13.717	6.2014	38.457
Uroflow maximum (ml)	120	6.0	18.0	11.667	2.9911	8.947
Post void residual (ml)	120	10.0	120.0	51.458	35.689	1273.69
Bladder wall thickness (cms)	120	0.2	0.4	0.258	0.0559	0.003
Ultrasound estimated bladder weight (gms)	120	22.0	60.0	38.321	10.5557	111.424
Bladder outlet obstruction index (BOOI) / Abraham Griffith (AG) Number	120	14.0	54.0	30.467	13.4070	179.747
Prostate volume	120	20.0	42.0	29.300	5.3367	28.481

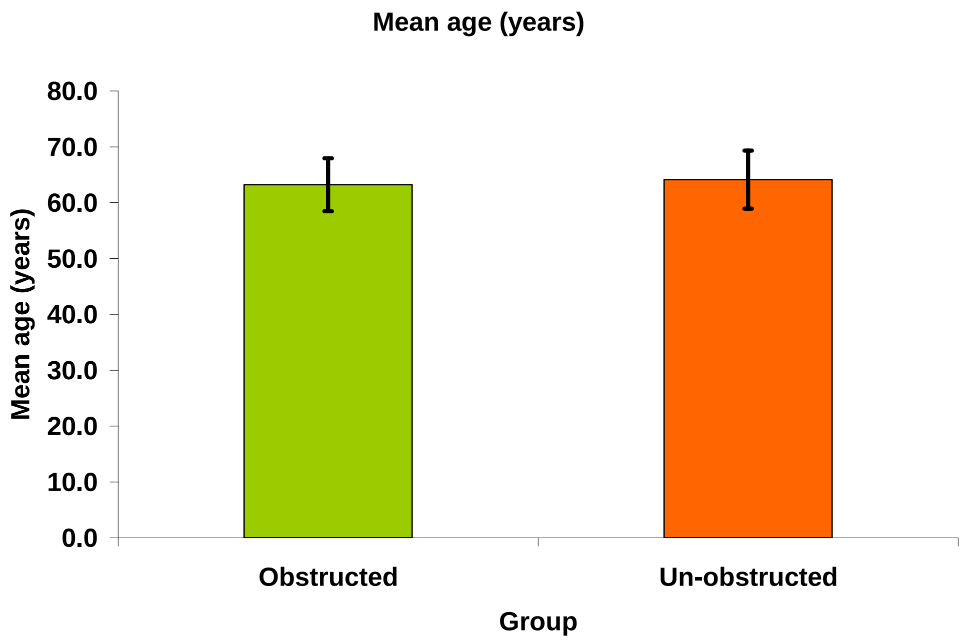
Out study comprises of 120 male patients who presented with obstructive lower urinary tract symptoms and benign prostatic enlargement. All patients were not on foley catheter. They were in the age group of 52-73 years (mean age is 61.3 years), International prostate symptoms score between 5-26 (mean 13.7). Their uroflow ranged between 6-18ml (mean 11ml) post void residual urine varied between 10-120ml (mean 51.45ml). Bladder wall thickness varied between 0.2 to 0.4cm (mean 0.258cm). Ultrasound estimated bladder weight varied between 22-66gms (mean 38.32gms). Mean prostate volume is 42cc.

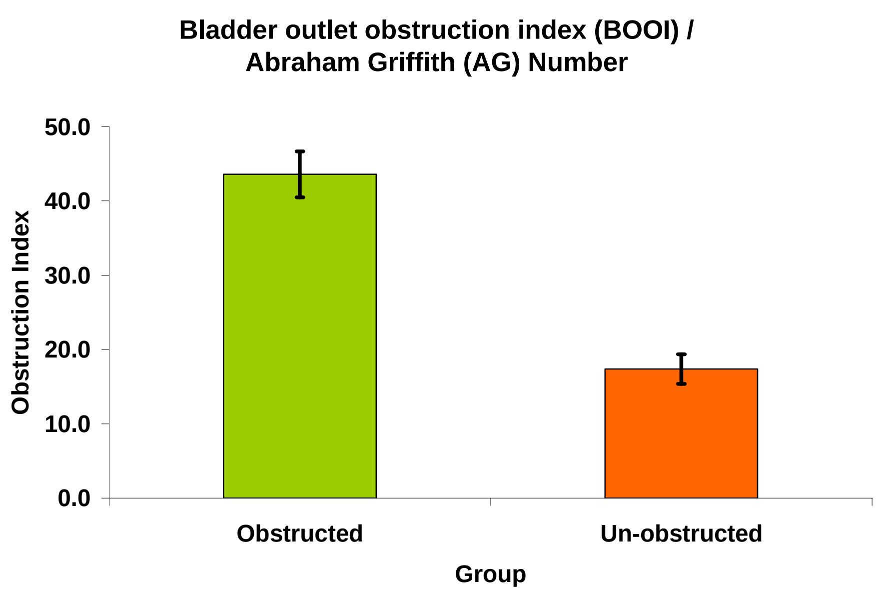
Age distribution



Group wise Age distribution




Mean age (years)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Mean age (years)
Obstructed
Un-obstructed
Group


Bladder outlet obstruction index (BOOI) /
Abraham Griffith (AG) Number
50.0
40.0
30.0
20.0
10.0
0.0
Obstruction Index
Obstructed
Un-obstructed
Group

Group I Non-obstructed	Number	Minimum	Maximum	Mean	Std. Dev	Variance
Age in years	60	53.0	73.0	64.133	5.1862	26.897
International Prostate symptom score	60	5.0	24.0	8.483	2.7831	7.745
Uroflow maximum (ml)	60	10.0	18.0	14.100	1.7143	2.939
Post void residual (ml)	60	10.0	30.0	18.417	6.4763	41.942
Bladder wall thickness (cms)	60	.2	.3	.210	.0303	.001
Ultrasound estimated bladder weight (gms)	60	22.0	42.0	28.792	4.3250	18.706
Bladder outlet obstruction index (BOOI) / Abraham Griffith (AG) Number	60	14.0	20.0	17.367	1.9997	3.999
Prostate volume	60	20.0	40.0	28.267	4.8916	23.928

In non obstructed group the age of the patients ranged from 53-73 years (mean 64.13years). International prostate symptoms score ranged between 5-24 (mean 8.48). Bladder wall thickness ranged between 0.2-0.3cm (mean 0.21cm). Ultrasound Estimated Bladder Weight ranged between 22-42gms (mean 28.79gms). Mean prostate volume is 28cc.

Group II Obstructed	Number	Minimum	Maximum	Mean	Std. Dev	Variance
Age in years	60	52.0	72.0	63.217	4.7411	22.478
International Prostate symptom score	60	8.0	26.0	18.950	3.7571	14.116
Uroflow maximum (ml)	60	6.0	14.0	9.233	1.7502	3.063
Post void residual (ml)	60	40.0	120.0	84.500	17.5079	306.525
Bladder wall thickness (cms)	60	.3	.4	.307	.0252	.001
Ultrasound estimated bladder weight (gms)	60	37.0	60.0	47.850	4.6197	21.342
Bladder outlet obstruction index (BOOI) / Abraham Griffith (AG) Number	60	40.0	54.0	43.567	3.0828	9.504
Prostate volume	60	20.0	42.0	30.333	5.5986	31.345

In obstructed group age of the patient ranged between 52-72 years (mean 63.21 years). International prostate symptoms score ranged between 8-26 (mean 18.95). Bladder wall thickness varied between 0.3-0.4cms (mean 0.30cms). Ultrasound estimated bladder weight ranged between 37-60gms (mean 47.85gms). Mean prostate volume 30cc.

Independent samples T-Test

	Group	Number	Mean	Std. Dev	P-Value
Age in years	Obstructed	60	63.217	4.7411	0.314
	Non-obstructed	60	64.133	5.1862	
International Prostate symptom score	Obstructed	60	18.950	3.7571	0.000
	Non-obstructed	60	8.483	2.7831	
Uroflow maximum (ml)	Obstructed	60	9.233	1.7502	0.000
	Non-obstructed	60	14.100	1.7143	
Post void residual (ml)	Obstructed	60	84.500	17.5079	0.000
	Non-obstructed	60	18.417	6.4763	
Bladder wall thickness (cms)	Obstructed	60	0.307	0.0252	0.000
	Non-obstructed	60	0.210	0.0303	
Ultrasound estimated bladder weight (gms)	Obstructed	60	47.850	4.6197	0.000
	Non-obstructed	60	28.792	4.3250	
Bladder outlet obstruction index (BOOI) / Abraham Griffith (AG) Number	Obstructed	60	43.567	3.0828	0.000
	Non-obstructed	60	17.367	1.9997	
Prostate volume	Obstructed	60	30.333	5.5986	0.033
	Non-obstructed	60	28.267	4.8916	

Factors like Age, International Prostate Symptoms Score, Uroflow, Post void residual urine, Bladder wall thickness, Ultrasound estimated bladder weight and prostate volume were compared between non obstructed and obstructed groups. Analysing every factors by independent sample T-test showed significant P value of <0.0001 for IPSS, Uroflow, PVR, BWT, Ultrasound Estimated Bladder Weight in obstructed group.

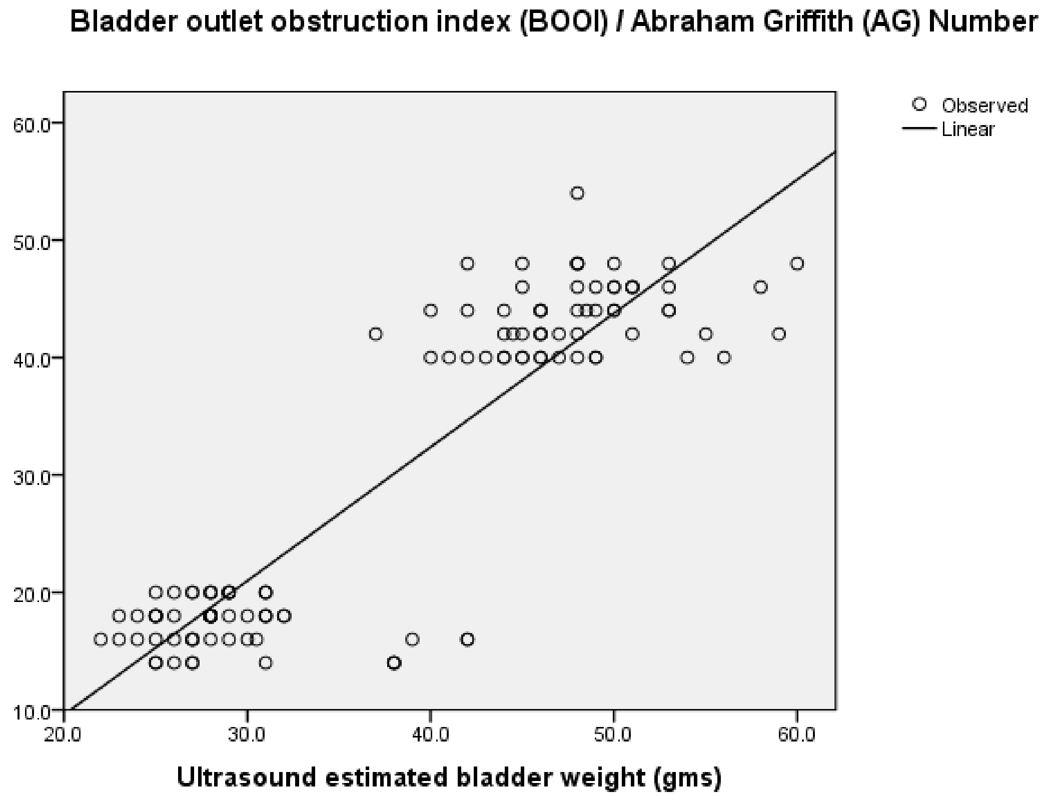
Simple linear Regression Analysis

Dependent Variable: Bladder outlet obstruction index (BOOI) / Abraham Griffith (AG) Number

Model Summary

Predictors	Constant	Regression Co-efficient	P-Value	R	R Square
Ultrasound estimated bladder weight (gms)	-13.191	1.139	0.000	0.897	0.805
International Prostate symptom score	5.266	1.837	0.000	0.850	0.722
Uroflow maximum (ml)	73.020	-3.647	0.000	-0.814	0.662
Post void residual (ml)	12.633	0.347	0.000	0.923	0.851
Bladder wall thickness (cms)	-21.478	201.08	0.000	0.838	0.703
Prostate volume	16.607	0.473	0.039	0.188	0.035

Regression Curve

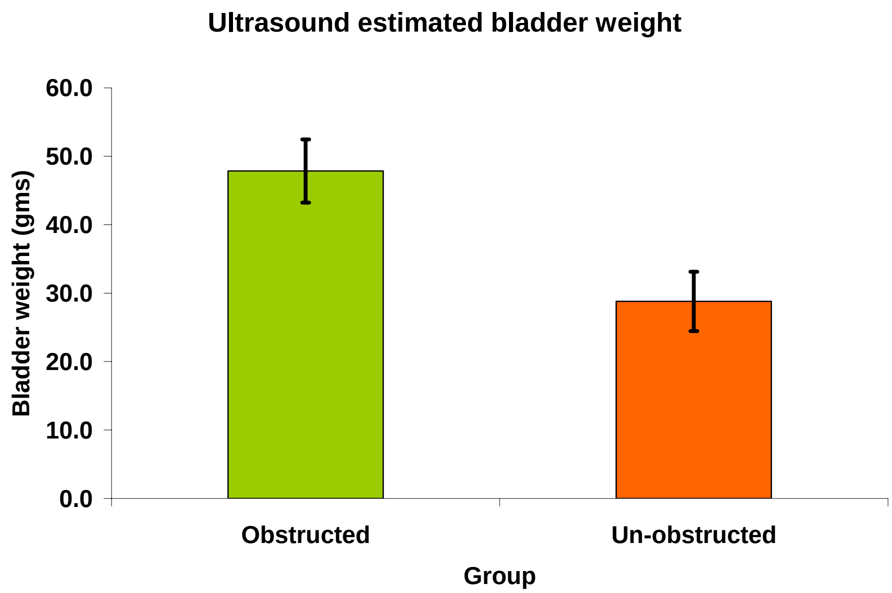


Ultrasound Estimated Bladder Weight of >39.5gms had 96.6% sensitivity, 98.3% specificity, 97.5% diagnostic accuracy of predicting bladder outlet obstruction in patients presenting with obstructive lower urinary tract symptoms and benign prostatic hyperplasia. Applying this Ultrasound estimated bladder weight 59 out of 60 patients fall in obstructed group. Area under the curve analysis (AUC) revealed a value of 0.996 for Ultrasound estimated bladder weight of 39.5gms which is most significant in diagnosing bladder outlet obstruction.

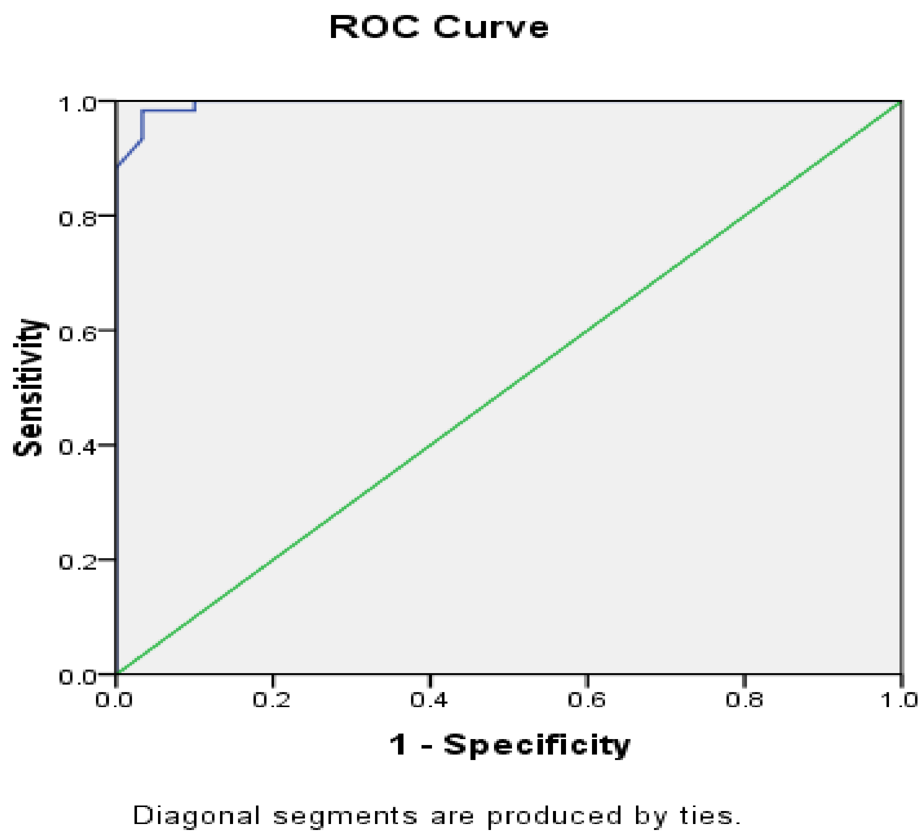
Sensitivity and Specificity

		Group		Total
		Non-obstructed	Obstructed	
UEBW	Nonobstructed (< 39.5)	58	1	59
	Obstructed (≥ 39.5)	2	59	61
Total		60	60	120

Measurement	Estimate (%)	95% CI (%)
Sensitivity	96.67	(88.64, 99.08)
Specificity	98.33	(91.14, 99.71)
Positive Predictive Value	98.31	(91, 99.7)
Negative Predictive Value	96.72	(88.81, 99.1)
Diagnostic Accuracy	97.5	(92.91, 99.15)
Likelihood ratio of a Positive Test	58	(8.16 - 412.2)
Likelihood ratio of a Negative Test	0.0339	(0.01272 - 0.09037)

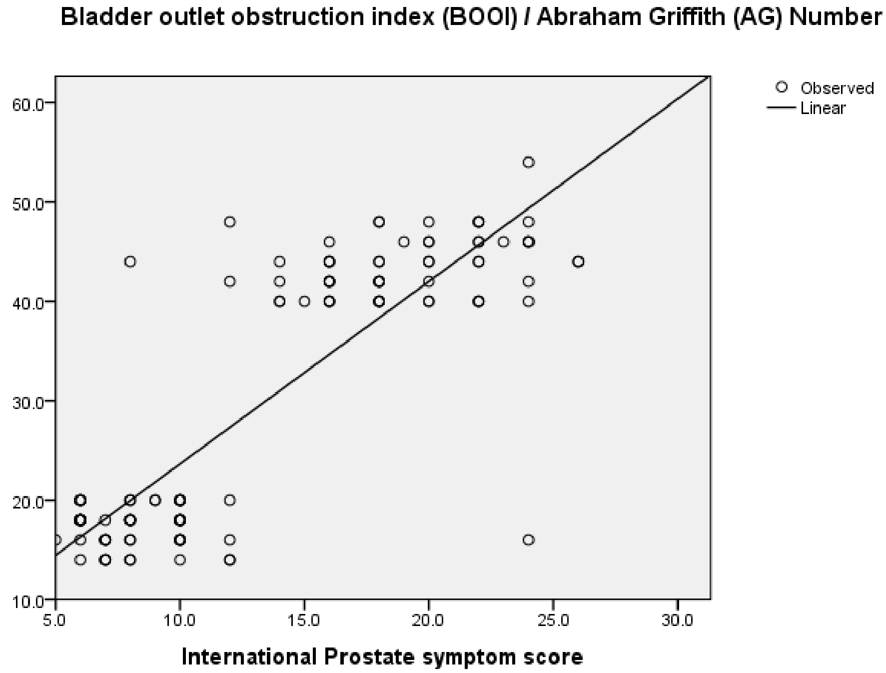

Ultrasound estimated bladder weight
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Bladder weight (gms)
Obstructed
Un-obstructed
Group

ROC Curve

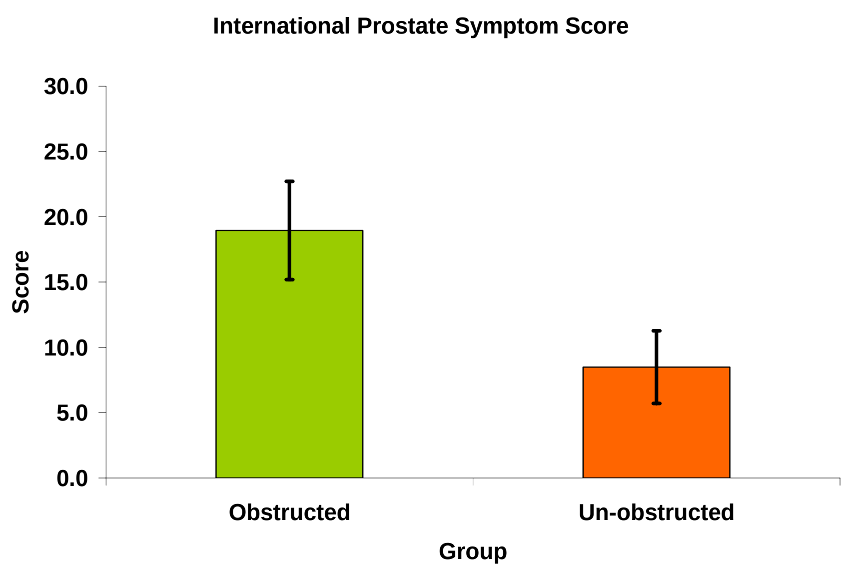


Area Under the Curve
Test Result Variable(s):Ultrasound estimated bladder weight (gms)
Area
0.996
The test result variable(s): Ultrasound estimated bladder weight (gms) has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

Regression Curve



International prostate symptoms score of >13 had 98% sensitivity, 95% specificity and 96% diagnostic accuracy in predicting bladder outlet obstruction among obstructed group. Area under the curve analysis revealed a value of 0.976 which is significant.

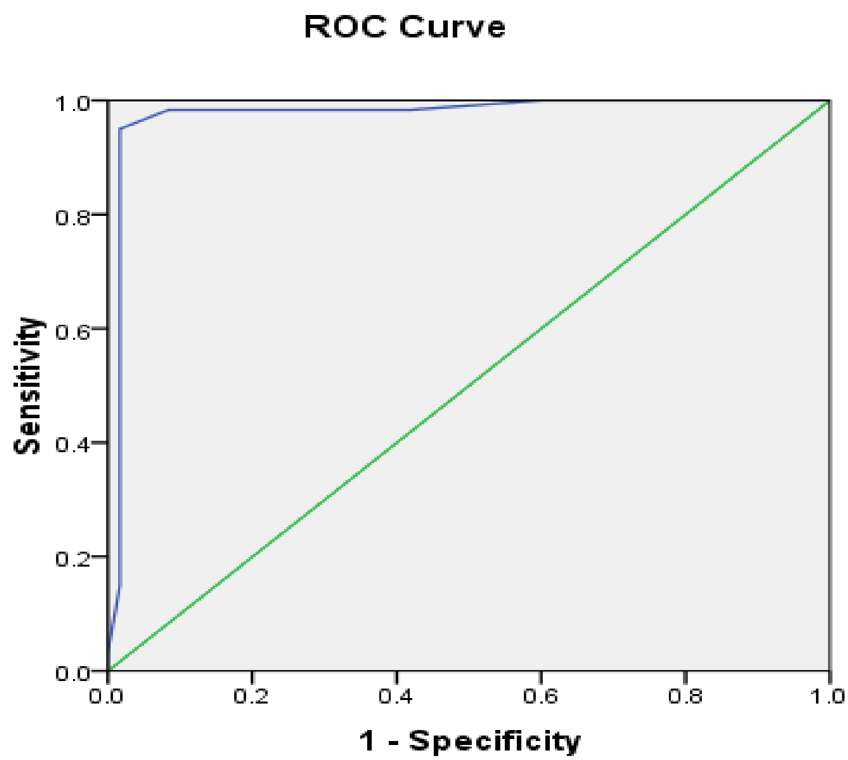


Sensitivity and Specificity

		Group		Total
		Non-obstructed	Obstructed	
IPSS	Nonobstructed (< 13.0)	59	3	62
	Obstructed (≥ 13.0)	1	57	58
Total		60	60	120

Measurement	Estimate (%)	95% CI (%)
Sensitivity	98.33	(91.14, 99.71)
Specificity	95.00	(86.3, 98.29)
Positive Predictive Value	95.16	(86.71, 98.34)
Negative Predictive Value	98.28	(90.86, 99.7)
Diagnostic Accuracy	96.67	(91.74, 98.7)
Likelihood ratio of a Positive Test	19.67	(10.23 - 37.82)
Likelihood ratio of a Negative Test	0.01754	(0.002467 - 0.1248)

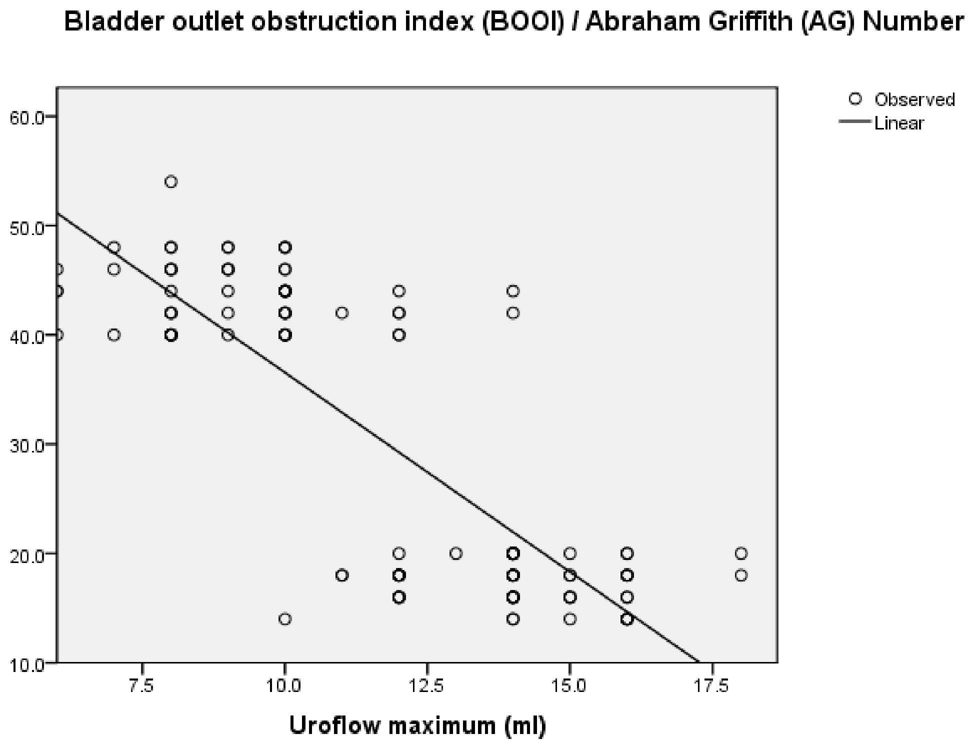
ROC Curve

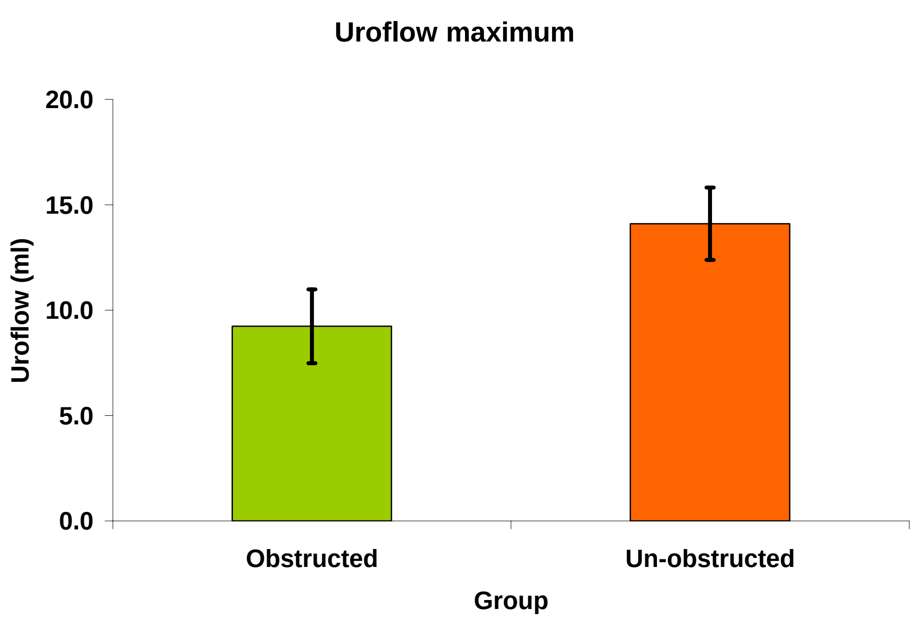


Diagonal segments are produced by ties.

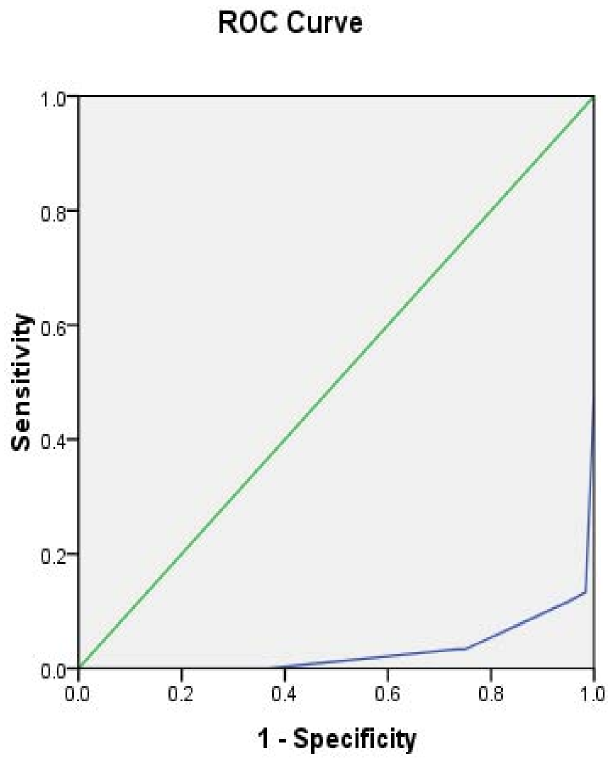
Area Under the Curve
Test Result Variable(s):International Prostate symptom score
Area
0.976
The test result variable(s): International Prostate symptom score has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

Regression Curve





ROC Curve

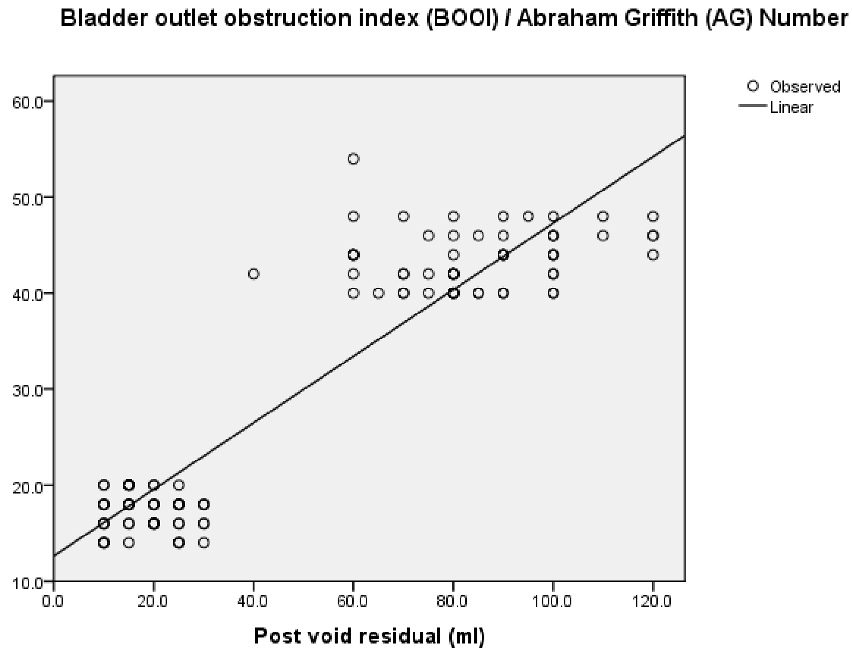


Diagonal segments are produced by ties.

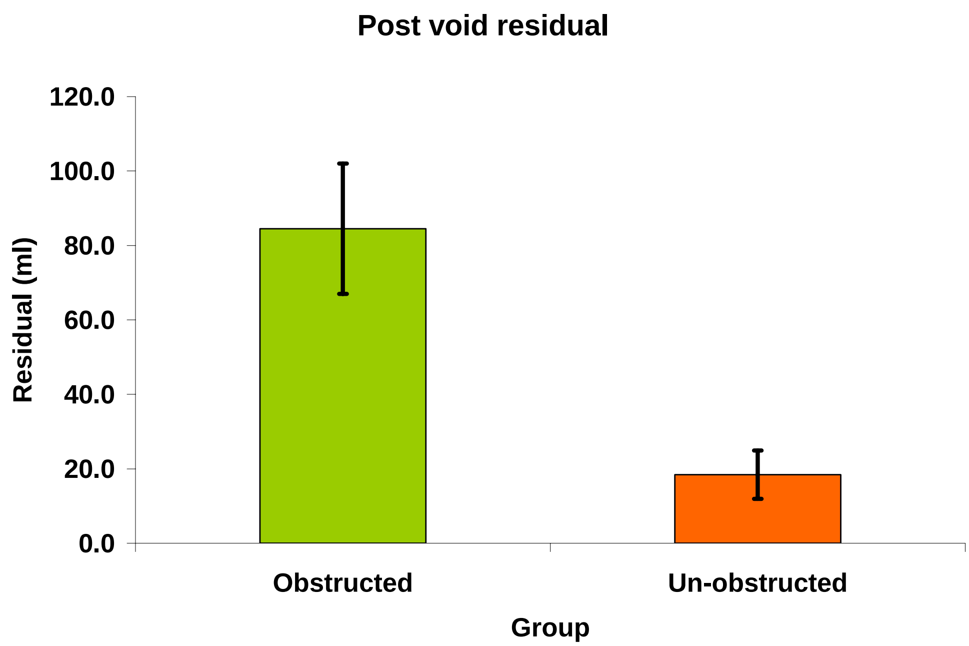
Area Under the Curve
Test Result Variable(s):Uroflow maximum (ml)
Area
0.031
The test result variable(s): Uroflow maximum (ml) has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

By area under the curve analysis, uroflow calculation has value of only 0.031, which is not significant in calculating bladder outlet obstruction

Regression Curve



Post void residual urine volume of >50ml had 100% sensitivity, 98% specificity and 99% diagnostic accuracy in predicting bladder outlet obstruction among obstructed group. Area under the curve analysis showed a value of 1.000 which is most significant.

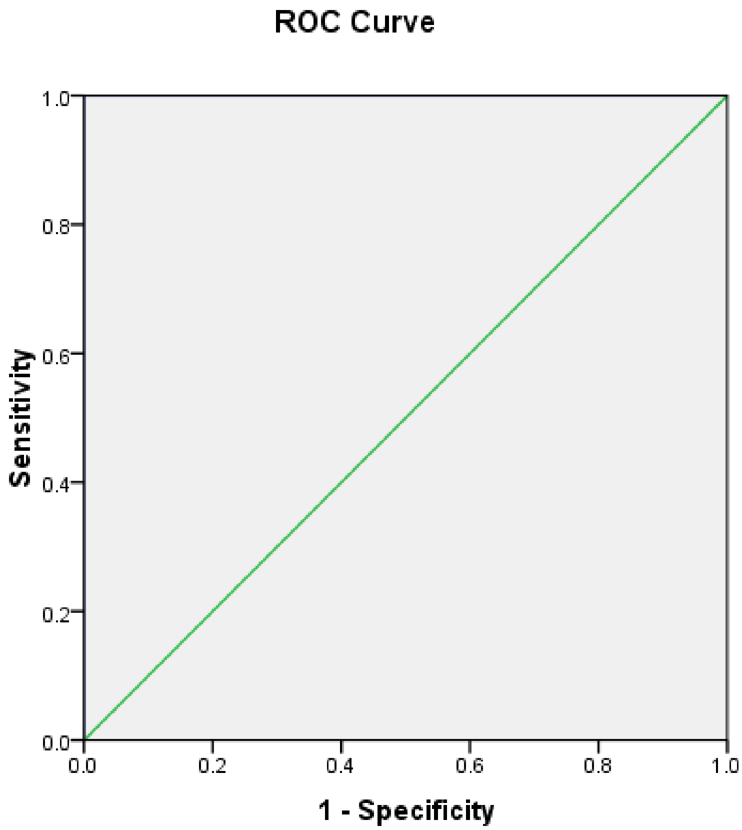

Post void residual
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Residual (ml)
Obstructed
Un-obstructed
Group

Sensitivity and Specificity

		Group		Total
		Non-obstructed	Obstructed	
PVR	Nonobstructed (< 50.0)	60	1	61
	Obstructed (≥ 50.0)	0	59	59
Total		60	60	120

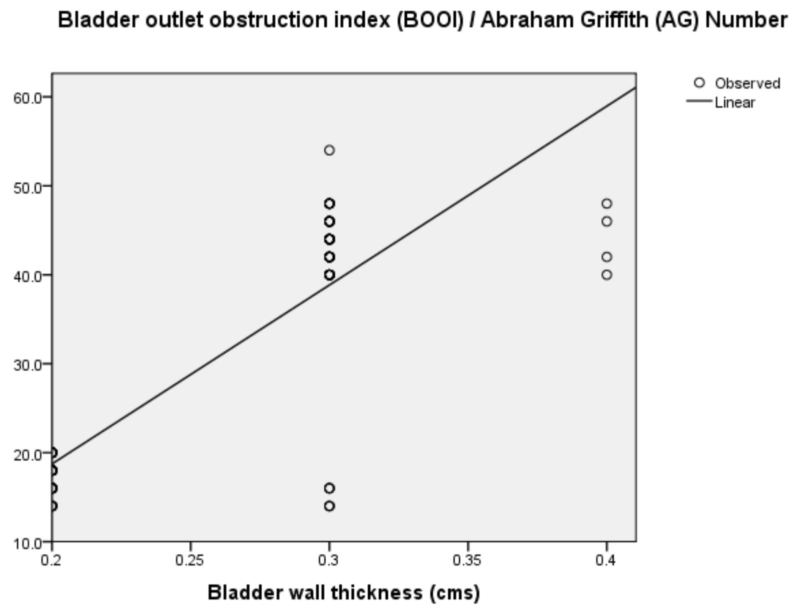
Measurement	Estimate (%)	95% CI (%)
Sensitivity	100.00	(93.98, 100)
Specificity	98.33	(91.14, 99.71)
Positive Predictive Value	98.36	(91.28, 99.71)
Negative Predictive Value	100.00	(93.89, 100)
Diagnostic Accuracy	99.17	(95.43, 99.85)
Likelihood ratio of a Positive Test	60	(8.5 - 426)
Likelihood ratio of a Negative Test	0.0	(0.0 – 0.0)

ROC Curve

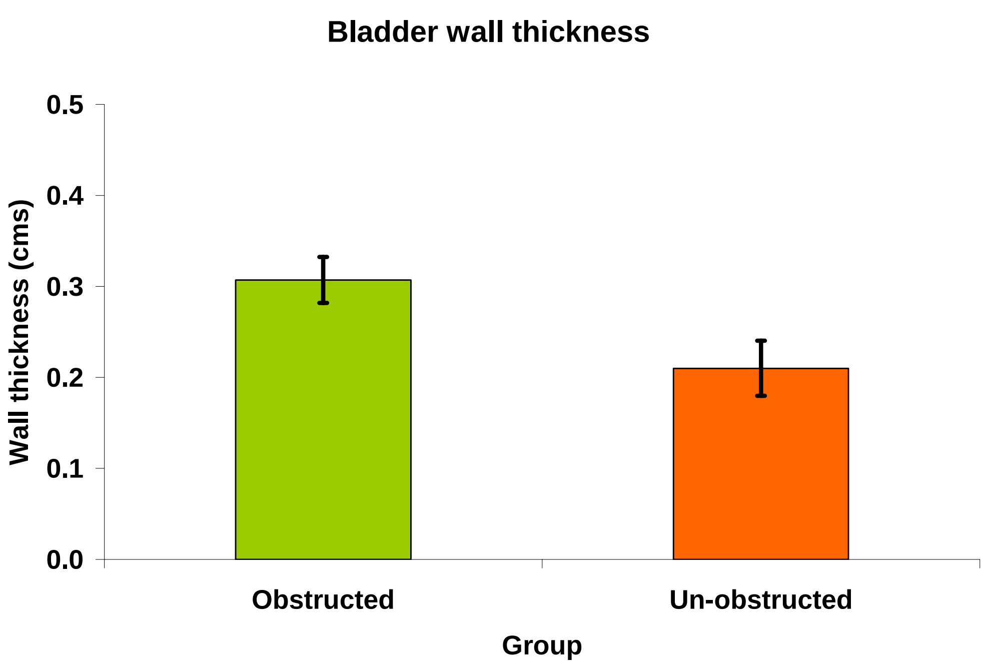


Area Under the Curve
Test Result Variable(s):Post void residual (ml)
Area
1.000

Regression Curve



Bladder Wall Thickness of >0.25cm has 90% sensitivity, 100% specificity and 95% diagnostic accuracy in predicting bladder outlet obstruction among obstructed group. Area under the curve analysis showed a value of 0.953 which is most significant.

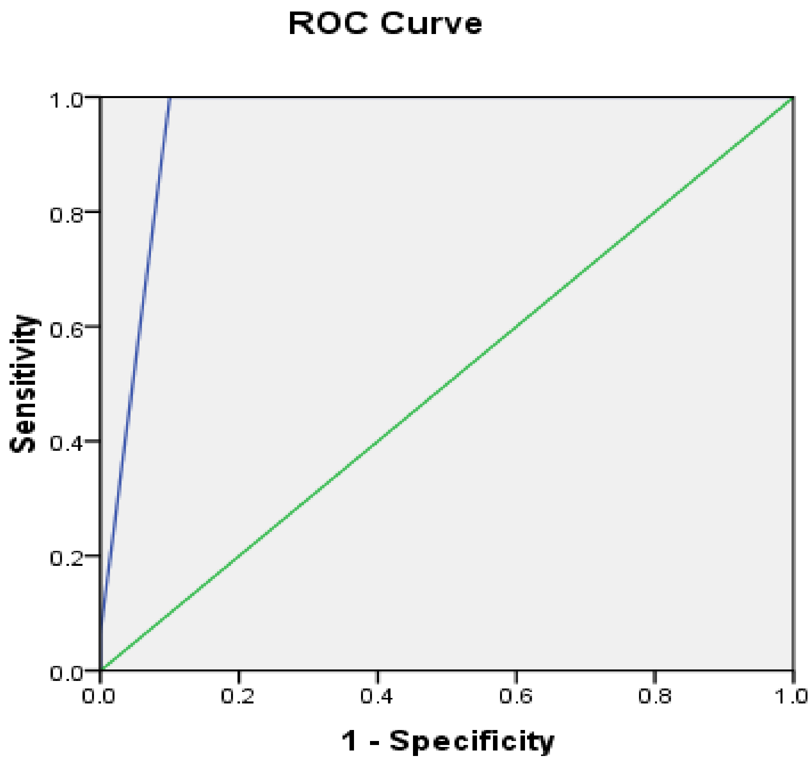


Sensitivity and Specificity

		Group		Total
		Non-obstructed	Obstructed	
BWT	Nonobstructed (< 0.25)	54	0	54
	Obstructed (≥ 0.25)	6	60	66
Total		60	60	120

Measurement	Estimate (%)	95% CI (%)
Sensitivity	90.00	(79.85, 95.34)
Specificity	100.00	(93.98, 100)
Positive Predictive Value	100.00	(93.36, 100)
Negative Predictive Value	90.91	(81.55, 95.77)
Diagnostic Accuracy	95.00	(89.52, 97.69)
Likelihood ratio of a Positive Test	undefined	
Likelihood ratio of a Negative Test	0.1	(0.07213 - 0.1386)

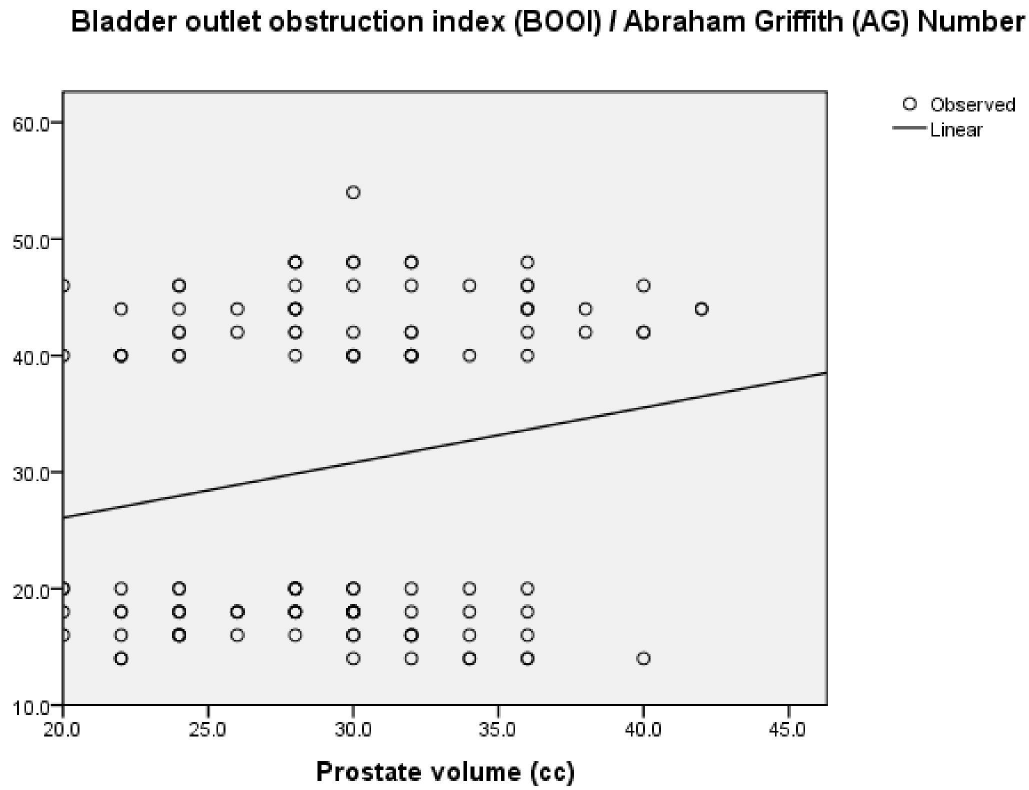
ROC Curve



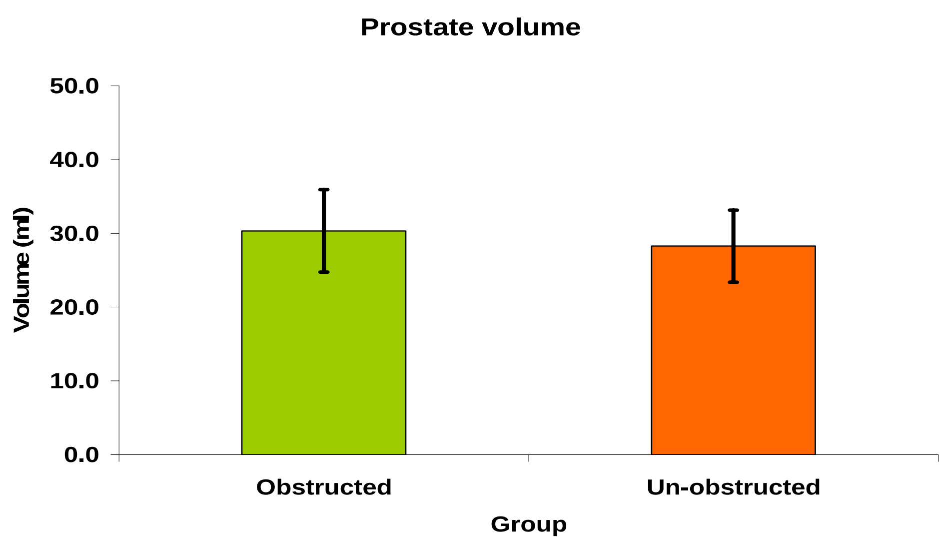
Diagonal segments are produced by ties.

Area Under the Curve
Test Result Variable(s):Bladder wall thickness (cms)
Area
0.953
The test result variable(s): Bladder wall thickness (cms) has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

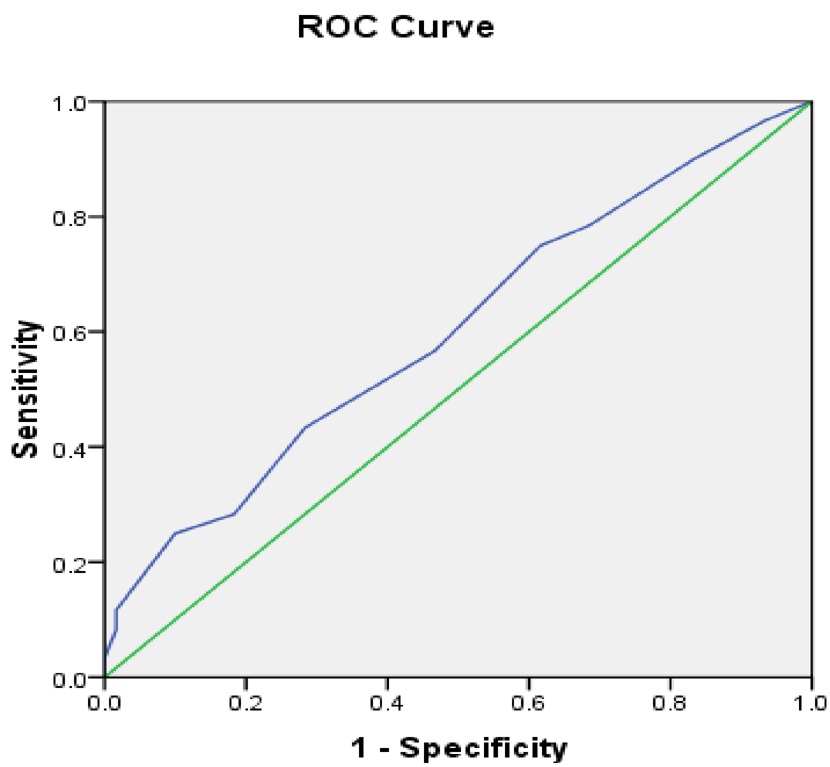
Regression Curve



Area under the curve analysis of prostate volume showed a value of 0.601 which is not much significant in diagnosing bladder outlet obstruction.


Prostate volume
50.0
40.0
30.0
20.0
10.0
0.0
Volume (ml)
Obstructed
Un-obstructed
Group

ROC Curve



Diagonal segments are produced by ties.

Area Under the Curve
Test Result Variable(s):Prostate volume
Area
0.601
The test result variable(s): Prostate volume has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

DISCUSSION

Lower urinary tract symptoms and bladder outlet obstruction is the commonest problem in urological practice.The definitive preoperative diagnosis of infravesical obstruction would contribute much toward consideration of treatment options for patients with urinary symptoms and decrease the number of surgical treatment failures significantly. In the past many efforts have been made to establish diagnostic standards capable of evaluating infravesical obstruction objectively.[39] The American Urological Association symptom index for BPH was reported to show a high correlation to patient global ratings of the magnitude of urinary disturbance caused by BPH and to discriminate strongly between BPH and control subjects.[40]

Netto et a1 examined the relationship between the International Prostatic Symptom Score (I-PSS) [41] and infravesical obstruction caused by BPH.[42]

Of their 111 patients with severe symptoms (scores 20 to 35) 92(82.9%) had bladder outlet obstruction caused by BPH compared to 53.4% of those with moderate symptoms (scores 8 to19**).** They concluded that I-PSS cannot be used for diagnosing prostatic obstruction but it can provide an important means of selecting patients who should undergo further urodynamics,that is pressure-flow studies. The authors recommended pressure-flow studies only in patients with a total I-PSS of less than 28**.** However, it is likely that the well-known lack of gender [43, 44] and disease [45] specificities of the symptom index to BPH makes it unreliable for predicting infravesical obstruction.

Uroflowmetry because of its noninvasiveness and easy to perform has commonly been used in the diagnostic evaluation of infravesical obstruction but with confusing results.[46-49] Siroky et al developed a flow rate nomogram relating bladder volume to maximum flow rate and reported a clear separation of patients with infravesical obstruction from the normal population using the nomogram [47]

In a study of 65 men with LUTS conducted by Kojima et al , ultrasound-estimated bladder weight correlated with the Abrams-Griffiths number

(r = 0.478, P<0.0001) . Mean (SD) bladder weight in the obstructed group was 46.2 (13.3) g which was significantly higher than that in the unobstructed group [29.3 (9.4) g, P<0.0001]. [31] Receiver operator characteristic (ROC) analysis suggested that a cut off value for ultrasound-estimated bladder weight of 35 g had 85% sensitivity and 87% specificity for diagnosis of obstruction.

In our study of 120 men with obstructive lower urinary tract symptoms mean (SD) bladder weigh in the obstructed group was 47.85 (4.6gms) which was significantly higher than in non obstructed group 28.79 (4.3g); P<0.0001. Receiver operator characteristic (ROC) analysis suggested that a cut off value of 39.5g has 96% sensitivity, 98% specificity, 97.5% diagnostic accuracy for predicting bladder outlet obstruction. Our results are comparable with Kojima et al study in diagnosing bladder outlet obstruction.

Kojima et al, also studied ultrasound-estimated bladder weight as a predictor of acute urinary retention (AUR) in a group of 160 men presenting with LUTS, 31 of whom suffered AUR. Patients presenting with AUR had higher mean (SD) ultrasound-estimated bladder weight at 50.5 (15.5) g than those presenting with LUTS but with good bladder emptying [34.7 (13.6) g, P<0.0001]. Again using analysis of the ROC curve, a cut off value of 40 g was used to predict the presence of AUR giving a sensitivity of 74% and specificity of 71%. [34]

In out study ultra sound estimated bladder weight is not studied as a predictor for acute urinary retention developing during follow up of patients.

A larger group of 234 patients were recruited by Ochai et al,to study the relationship between ultrasound-estimated bladder weight and other relevant variables including AUA symptom score, maximum flow rate (Q_{max}), post-void residual (PVR) and presumed circle area ratio of the prostate. Multiple regression analysis showed that PVR ($r = 0.490$, $P<0.0001$) and presumed circle area of prostate ($r = 0.468$, $P <0.0001$) were significant independent determinants of ultrasound-estimated bladder weight.[32]

In out study by multiple regression analysis relationship between ultrasound estimated bladder weight and other relevant variables analyzed. It showed that International prostate symptoms score of ($r=0.850$, $P=0.0001$) Post void residual urine ($r=0.923$, $P=0.0001$) and Bladder wall thickness ($r=0.838$, $P=0.0001$) were significant independent determinants of ultrasound estimated bladder weight in calculating bladder outlet obstruction. So our results are comparable to Ochai et al study.

Guzman et al. presented data from 30 men with confirmed bladder outlet obstruction diagnosed using the Schafer nomogram. The results showed that ultrasound-estimated bladder weight correlated positively with the international prostate symptom score (IPSS; r = 0.710, P = 0.0012) and with maximum detrusor pressure (r = 0.710, P = 0.299) and it correlated negatively with Q_{max} (r = -0.873, P = 0.00001). Nevertheless there was no significant correlation between the bladder weight and the residual urine. [50]

In our study by multiple regression analysis, Receiver operator characteristic (ROC) curves analysis and calculation of the area under the curve (AUC) , ultrasound-estimated bladder weight correlated positively with the international prostate symptom score [IPSS], Uroflow, Postvoid residual urine and bladder wall thickness [BWT] and it correlated negatively with prostate volume.

CONCLUSION

Ultrasound Estimated Bladder Weight can be used as a non invasive bedside test to diagnose bladder outlet obstruction in elderly men having benign prostatic hyperplasia and presenting with obstructive urinary symptoms.

BIBLIOGRAPHY

1 .Reynard JM, Yang Q, Donovan JL, Peters TJ, Schafer W, de la Rosette JJ *et al* .

The ICS-′BPH′ study: Uroflowmetry, lower urinary tract symptoms and bladder outlet obstruction. Br J Urol 1998;82:619-23

2. Yalla SV, Sullivan MP, Lecamwasam HS, Dubeau CE, Vickers MA, Cravalho EG. Correlation of american urological association symptom index with obstructive and nonobstructive prostatism. J Urol 1995;153:674-9.

3. Homma Y, Gotoh M, Takei M, Kawabe K, Yamaguchi T. Predictability of conventional tests for the assessment of bladder outlet obstruction in benign prostatic hyperplasia. Int J Urol 1998;5:61-6.

4 .Oelke M, Hofner K, Jonas U, de la Rosette JJ, Ubbink DT, Wijkstra H. Diagnostic accuracy of noninvasive tests to evaluate bladder outlet obstruction in men: Detrusor wall thickness, uroflowmetry, postvoid residual urine, and prostate volume. Eur Urol 2007;52:827-34.

5. Levin RM, Haugaard N, O′Connor L, Buttyan R, Das A, Dixon JS *et al* . Obstructive response of human bladder to bph vs. rabbit bladder response to partial outlet obstruction: A direct comparison. Neurourol Urodyn 2000;19:609-29

6. Jequier S, Rousseau O. Sonographic measurements of the normal bladder wall in children. AJR Am J Roentgenol 1987;149:563-6.

7. Manieri C, Carter SS, Romano G, Trucchi A, Valenti M, Tubaro A. The diagnosis of bladder outlet obstruction in men by ultrasound measurement of bladder wall thickness.

J Urol 1998;159:761-5

8. Oelke M, Hofner K, Jonas U, Ubbink D, de la RJ, Wijkstra H. Ultrasound measurement of detrusor wall thickness in healthy adults. Neurourol Urodyn 2006;25:308-17

9. Khullar V, Salvatore S, Cardozo L, Bourne TH, Abbott D, Kelleher C. A novel technique for measuring bladder wall thickness in women using transvaginal ultrasound. Ultrasound Obstet Gynecol 1994;4:220-3.

10. Kojima M, Inui E, Ochiai A, Naya Y, Ukimura O, Watanabe H. Ultrasonic estimation of bladder weight as a measure of bladder hypertrophy in men with infravesical obstruction: A preliminary report. Urology 1996;47:942-7.

11. Kuzmic AC, Brkljacic B, Ivankovic D. Sonographic measurement of detrusor muscle thickness in healthy children. Pediatr Nephrol 2001;16:1122-5.

12. Harris RA, Follett DH, Halliwell M, Wells PN. Ultimate limits in ultrasonic imaging resolution. Ultrasound Med Biol 1991;17:547-58

13.Klingler HC, Madersbacher S, Djavan B et al:Morbidity of the evaluation of the lower urinarytract with transurethral multichannel pressureflowstudies. J Urol 1998; **159:** 191.

14. Mattiasson A and Uvelius B: Changes in contractileproperties in hypertrophic rat urinary bladder.J Urol 1982; **128:** 1340.

15. Ghoniem GM, Regnier CH, Biancani P et al: Effectof vesical outlet obstruction on detrusor contractilityand passive properties in rabbits. J Urol1986; **135:** 1284.

16. Malkowicz SB, Wein AJ, Elbadawi A et al: Acutebiochemical and functional alterations in the partiallyobstructed rabbit urinary bladder. J Urol1986; **136:** 1324.

17. Nielsen KK, Andersen CB, Petersen LK et al:Morphological, stereological, and biochemicalanalysis of the mini-pig urinary bladder afterchronic outflow obstruction and after recoveryfrom obstruction. Neurourol Urodyn 1995; **14:**269.

18. Beamon CR, Mazar C, Salkini MW et al: Theeffect of sildenafil citrate on bladder outlet obstruction:a mouse model. BJU Int 2009; **104:**252.

19. Gilpin SA, Gosling JA and Barnard RJ: Morphologicaland morphometric studies of the humanobstructed, trabeculated urinary bladder. Br JUrol 1985; **57:** 525.

20. Elbadawi A, Yalla SV and Resnick NM: Structuralbasis of geriatric voiding dysfunction. IV. Bladderoutlet obstruction J Urol 1993; **150:** 1681.

21. Elbadawi A, Yalla SV and Resnick NM: Structuralbasis of geriatric voiding dysfunction. III. Detrusoroveractivity J Urol 1993; **150:** 1668.

22. Landau EH, Jayanthi VR, Churchill BM et al: Lossof elasticity in dysfunctional bladders: urodynamicand histochemical correlation. J Urol 1994;**152:** 702.

23. El Din KE, de Wildt MJ, Rosier PF et al: Thecorrelation between urodynamic and cystoscopicfindings in elderly men with voiding complaints.J Urol 1996; **155:** 1018.

24. Abrams PH, Roylance J and Feneley RC: Excretionurography in the investigation of prostatism. Br JUrol 1976; **48:** 681.

25. Schoor RA, Canning DA, Bella RD et al: Ultrasounddiagnosis of bladder outlet obstruction inrabbits. Neurourol Urodyn 1994; **13:** 559.

26. Hakenberg OW, Linne C, Manseck A et al: Bladderwall thickness in normal adults and men withmild lower urinary tract symptoms and benignprostatic enlargement. Neurourol Urodyn 2000;**19:** 585.

27. Blatt AH, Titus J and Chan L: Ultrasound measurementof bladder wall thickness in the assessmentof voiding dysfunction. J Urol 2008; **179:**2275.

28. Oelke M, Hofner K, Wiese B et al: Increase indetrusor wall thickness indicates bladder outletobstruction (BOO) in men. World J Urol 2002; **19:**443.

29. Kessler TM, Gerber R, Burkhard FC et al: Ultrasoundassessment of detrusor thickness in men can it predict bladder outlet obstruction and replace pressure flow study? J Urol 2006; **175:**2170

30. Isikay L, Turgay Akgul K, Nuhoglu B et al: Lowerurinary tract symptoms, prostate volume, uroflowmetry,residual urine volume and bladderwall thickness in Turkish men: a comparativeanalysis. Int Urol Nephrol 2007; **39:** 1131.

31. Kojima M, Inui E, Ochiai A et al: Noninvasivequantitative estimation of infravesical obstructionusing ultrasonic measurement of bladder weight.J Urol 1997; **157:** 476-9.

32. Ochiai A and Kojima M: Correlation of ultrasound-estimated bladder weight with ultrasoundappearance of the prostate and postvoid residualurine in men with lower urinary tract symptoms.Urology 1998; **51:** 722.-9.

33 Kojima. M, Inui E, Ochiai A et al: Reversiblechange of bladder hypertrophy due to benignprostatic hyperplasia after surgical relief of obstruction.J Urol 1997; **158:** 89.

34. Miyashita H, Kojima M and Miki T: Ultrasonicmeasurement of bladder weight as a possiblepredictor of acute urinary retention in men withlower urinary tract symptoms suggestive of benignprostatic hyperplasia. Ultrasound Med Biol2002; **28:** 985-90.

35. Akino H, Maekawa M, Nakai M et al: Ultrasoundestimatedbladder weight predicts risk of surgeryfor benign prostatic hyperplasia in men usingalpha-adrenoceptor blocker for LUTS. Urology2008; **72:** 817.

36. Chalana V, Dudycha S, Yuk JT, Mcmorrow G. Automatic measurement of Ultrasound-Estimated Bladder Weight (UEBW) from three-dimensional ultrasound. Rev Urol 2005;7:S22-8.

37. Inui E, Ochiai A, Naya Y, Ukimura O, Kojima M. Comparative morphometric study of bladder detrusor between patients with benign prostatic hyperplasia and controls.

J Urol 1999;161:827-30.

38. St Sauver J, Jacobson D, Rule A, Mcgree M, Lieber M, Nehra A, *et al* . Measures of bladder wall thickness, surface area, and estimated bladder weight in a population-based group of men. J Urol 2008;179:525

39. Abrams, P.: Objective evaluation of bladder outlet obstruction. Brit. J. Urol., suppl., 76: 11, 1995

40 .Barry, M. J., Fowler, F. J., O'Leary, M. P., Bruskewitz, R. C.,Holtgrewe, H. L., Mebust, W. K., Cockett, A. T. K. and Measurement Committee of the American

Urological Association: The American Urological Association Symptom Index for benign prostatic hyperplasia. J. Urol., 148: 1549, 1992.

41. Netto, N. R., Jr., D'Ancona, C. A. L. and de Lima, M. L.: Correlation between the international prostatic symptom score and a pressure-flow study in the evaluation of symptomatic benign prostatic hyperplasia. J. Urol., 155 200, 1996

42.Cockett, A. T. K., Khoury, S., Aso, Y., Chatelain, C., Denis, L.. Griffiths, K. and Murphy, G.: The 2nd International Consultation on Benign Prostatic Hyperplasia. Channel Island: Scientific Communication International Ltd., pp. 624-631, 1994

43Chai, T. C., Belville, W. D., McGuire, E. J. and Nyquist, L.: Specificity of the American Urological Association Voiding Symptom Index. Comparison of unselected and selected samples of both sexes. J. Urol., 150: 1710, 1993.

44. Lepor, H. and Machi, G.: Comparison of AUA Symptom Index in unselected males and females between fifty-five and seventynine years of age. Urology, 42 36, 1993

45.. Chancellor, M. B., Rivas, D. A,, Keeley, F. X., Lotfi, M. A. and Gomella, L. G.: Similarity of the American Urological AssociationSymptom Index among men with benign prostate hyperplasia(BPH), urethral obstruction not due to BPH and detrusorhyperreflexia without outlet obstruction. Brit. J. Urol., 74:200, 1994

46.Shoukry, I., Susset, J. G., Elhilali, M. M. and Dutartre, D.: Role of uroflowmetry in the assessment of lower urinary tract obstruction in adult males. Brit. J. Urol., 47: 559, 1975.

47. Siroky, M. B., Olsson, C. A. and Krane, R. J.: The flow rate nomogram. 11. Clinical correlation. J. Urol., 123 208, 1980.

48. Gleason, D. M., Bottaccini, M. R., Drach, G. W. and Layton, T. N.: Urinary flow velocity as an index of male voiding function. J. Urol., 128: 1363, 1982.

49. Chancellor, M. B., Blaivas, J. G., Kaplan, S. A. and Axelrod, S.:Bladder outlet obstruction versus impaired detrusor contractility. The role of uroflow. J. Urol., 145: 810, 1991

50. Guzman H, Arroyo C, Gabilondo F. Comparative study between bladder weight by ultrasound, IPSS And urodynamics for infravesical obstruction. J Urol 2000;163:48.

IPSS Score Card

கடந்த மாதம் எத்தனை முறை	முற்றும் இல்லை	ஒன்றுக்கும் குறைவு	பாதிக்கும் கீழ்	பாதிமுறை	பாதிமுறைக்கு மேல்	ஏறக்குறைய எல்லாமுறை	**Your Score**
கேள்வி							
1. சிறுநீர் கழித்த பின்பும் முற்றும் கழிக்காத வேதனை	0	1	2	3	4	5	
2. இரண்டு மணி நேரத்தில் மீண்டும் சிறுநீர் கழித்தல்	0	1	2	3	4	5	
3. பலமுறை சிறுநீர் கழிக்க வேண்டிய நிலை	0	1	2	3	4	5	
4. சிறுநீர் கழிக்க அவசரம்	0	1	2	3	4	5	
5. சிறுநீர் அளவு	0	1	2	3	4	5	
6. சிறுநீர் கழிக்க அவதி	0	1	2	3	4	5	
7. எத்தனை முறை இரவில் எழுந்தீர்கள்	0	1	2	3	4	5	

Total IPSS score	

Laboratories only

International Prostate Symptom Score (I-PSS)

	None	Less than once every 5 times	Less than once every 2 times	About once every 2 times	More than once every 2 times	Almost always
1. Have you felt like your bladder is not completely empty after urination in the past month ?	0	1	2	3	4	5
2. Have you had to go to the toilet within 2 hours of doing so in the past month ?	0	1	2	3	4	5
3. Have you had disrupted urination in the past month ?	0	1	2	3	4	5
4. Have you found it hard to control your urine in the past month ?	0	1	2	3	4	5
5. Have you had a case of weak urination in the past month ?	0	1	2	3	4	5
6. Have you had to strain to initiate urination in the past month?	0	1	2	3	4	5
	None	Once	Twice	3 times	4 times	5times or more
7. How many times did you, on average, get up to urinate at night after going to bed in the past month ?	0	1	2	3	4	5

Score : 0-7 mild 8-19 moderate 20-35 severe **I-PSS Total score =**

QOL (Quality of Life) regarding Urinating Condition

How would you feel if the present urinating condition continues for the rest of your life ? Please (✓)

- ☐ Happy
- ☐ Neither satisfied nor dissatisfied
- ☐ Satisfied
- ☐ Somewhat dissatisfied
- ☐ Almost satisfied
- ☐ Depressed
- ☐ Unbearable

INSTITUTIONAL ETHICAL COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI-600 003

Telephone 25363970
Fax 044 2535115
Dated : 07.04.2010

L.Dis No.14597/ME5/Ethics Dean/MMC/2010

Title of the work : " The use of ultrasound estimated Bladder weight in Diagnosing Bladder Outlet obstruction"

Principal Investigator : Dr. S. Senthil Kumar
Designation : PG in M.Ch. Urology
Department : Dept. of Urology. Madras Medical College, ch-3

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 7th April 2010 at 2.p.m in Pharmacology Seminar Hall, Madras Medical College, Chennai -3.

The members of the Committee, the Secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should get detailed informed consent from the patients/participants and maintain confidentiality.
2. You should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.
3. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
4. You should not deviate form the area of the work for which you applied for ethical clearance.
5. You should inform the IEC immediately, in case of any adverse events or serious adverse reactions.
6. You should abide to the rules and regulation of the institution(s).
7. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
8. You should submit the summary of the work to the ethical committee on completion of the work.
9. You should not claim funds from the Institution while doing the work or on completion.
10. You should understand that the members of IEC have the right to monitor the work with prior intimation.

SECRETARY
IEC, MMC,CHENNAI

CHAIRMAN
IEC,MMC,CHENNAI

DEAN
MADRAS MEDICAL COLLEGE,
CHENNAI -3

THE USE OF ULTRASOUND ESTIMATED BLADDER WEIGHT IN DIAGNOSING BLADDER OUTLET OBSTRUCTION

PROFORMA

NAME: AGE & SEX

ADDRESS:

PHONE NO: URO NO:

HISTORY:

.
LUTS;

DM/HT/PT H/O DRUG INTAKE

PREVIOUS INTERVENTION/ SURGERY

G/E::

GENITALIA:

P.R:

INVESTIGATIONS:

IPSS QUESTIONNAIRE

USG-KUB

UROFLOW

PVR

PRESSURE-FLOW STUDIES

MASTER CHART

S.NO	AGE	IPSS	QMAX	PVR	BWT	UEBW	AG NO	PR.VOL
1	52	18	8	80	0.3	44.5	42	40
2	55	23	6	100	0.4	58	46	36
3	60	12	12	40	0.3	37	42	32
4	59	18	7	80	0.3	45	40	24
5	66	16	6	90	0.3	48.5	44	28
6	60	22	9	100	0.3	46	44	42
7	58	24	8	90	0.3	48	48	28
8	66	24	8	80	0.4	59	42	26
9	65	18	9	70	0.3	40	40	20
10	70	20	6	90	0.3	42	44	28
11	67	14	10	80	0.3	41	40	32
12	62	8	12	60	0.3	40	44	36
13	59	16	10	100	0.3	44	42	30
14	69	15	8	80	0.3	43	40	30
15	70	22	7	100	0.3	45	46	28
16	63	18	12	75	0.3	46	42	24
17	68	16	10	60	0.3	44	40	22
18	67	16	9	80	0.3	46	42	32
19	69	16	10	120	0.3	48	44	36
20	72	20	8	80	0.3	48	46	30
21	56	18	8	90	0.3	47	40	30
22	61	16	14	60	0.3	49	44	36
23	65	18	9	100	0.3	48	48	32
24	71	20	8	85	0.3	49	40	28
25	70	16	8	80	0.3	46	42	28
26	68	18	10	100	0.3	50	44	26
27	65	20	14	70	0.3	48	42	36
28	67	22	10	100	0.3	48	40	22
29	66	24	8	120	0.3	51	46	24
30	62	18	10	100	0.3	47	42	28
31	59	14	10	80	0.3	46	40	32
32	59	22	9	90	0.3	50	46	34
33	58	12	10	70	0.3	50	48	36
34	63	19	9	110	0.3	51	46	40
35	57	18	10	80	0.3	51	42	38
36	64	22	8	95	0.3	53	48	30
37	64	24	10	100	0.3	53	46	32
38	70	26	10	90	0.3	53	44	42
39	60	16	11	70	0.3	55	42	40
40	70	14	10	60	0.3	50	44	38
41	63	14	10	60	0.3	45	42	24
42	59	16	9	75	0.3	50	46	24
43	65	20	8	80	0.3	46	44	28
44	67	16	12	100	0.3	49	40	34

S.NO	AGE	IPSS	QMAX	PVR	BWT	UEBW	AG NO	PR.VOL
45	58	20	8	80	0.3	45	40	32
46	68	16	8	70	0.4	56	40	36
47	62	22	10	100	0.3	46	44	28
48	59	18	10	60	0.3	44	44	24
49	65	24	12	90	0.3	42	40	22
50	59	22	10	60	0.3	45	48	28
51	61	22	10	120	0.4	60	48	30
52	63	20	7	80	0.3	42	48	32
53	57	22	6	65	0.3	44	40	32
54	65	20	10	85	0.3	49	46	36
55	56	24	8	60	0.3	48	54	30
56	60	22	10	75	0.3	46	40	30
57	70	18	8	85	0.3	54	40	24
58	64	18	9	110	0.3	48	48	28
59	63	24	8	120	0.3	51	46	20
60	57	26	10	90	0.3	53	44	22
61	64	6	15	20	0.2	23	16	24
62	63	7	14	30	0.2	25	18	30
63	57	6	12	20	0.2	28	18	28
64	67	5	14	10	0.2	30.5	16	32
65	62	7	14	10	0.3	38	14	36
66	65	10	12	20	0.2	24	18	30
67	54	10	14	10	0.2	23	18	28
68	56	8	12	20	0.3	39	16	26
69	53	10	12	30	0.3	42	16	22
70	64	7	14	10	0.2	22	16	24
71	67	12	10	30	0.3	38	14	40
72	69	6	12	20	0.2	25	18	32
73	63	10	15	20	0.2	25	16	30
74	72	6	15	10	0.2	25	14	34
75	70	7	14	20	0.2	27	16	36
76	65	6	14	10	0.2	26	20	28
77	59	6	16	15	0.2	28	18	26
78	63	6	14	20	0.2	27	20	22
79	73	6	14	15	0.2	28	20	20
80	63	8	13	15	0.2	29	20	28
81	60	8	12	25	0.2	28	18	24
82	56	7	16	15	0.2	26	14	22
83	63	8	14	15	0.2	28	18	20
84	59	8	14	20	0.2	29	20	24
85	66	6	14	10	0.2	28	18	30
86	59	10	16	25	0.2	29	16	32
87	67	9	16	15	0.2	29	20	34
88	69	6	12	25	0.2	31	18	36
89	65	8	14	10	0.2	30	18	30
90	69	7	16	15	0.2	30	16	30

S.NO	AGE	IPSS	QMAX	PVR	BWT	UEBW	AG NO	PR.VOL
91	72	10	18	15	0.2	29	20	30
92	71	8	16	25	0.2	31	14	32
93	73	6	11	30	0.2	32	18	34
94	69	10	14	15	0.2	31	20	36
95	62	9	15	15	0.2	28	20	28
96	68	10	16	25	0.2	28	18	24
97	61	10	15	25	0.2	31	18	22
98	72	10	14	25	0.2	31	20	30
99	61	10	12	15	0.2	29	18	28
100	64	12	15	20	0.2	27	16	32
101	60	24	14	25	0.2	24	16	34
102	64	8	16	10	0.2	27	14	36
103	60	8	16	10	0.2	26	18	30
104	56	10	16	25	0.2	25	18	28
105	57	8	14	10	0.2	26	16	24
106	69	10	16	25	0.2	25	14	22
107	62	10	14	10	0.2	25	20	20
108	63	12	12	15	0.2	27	20	24
109	69	10	15	25	0.2	31	18	26
110	61	10	12	15	0.2	28	16	28
111	69	12	16	25	0.2	27	14	30
112	73	10	16	15	0.2	31	20	32
113	62	7	14	10	0.3	38	14	34
114	58	10	12	30	0.3	42	16	20
115	67	6	12	20	0.2	25	18	22
116	68	7	14	20	0.2	27	16	24
117	57	6	18	15	0.2	28	18	26
118	61	6	14	15	0.2	28	20	28
119	69	8	14	15	0.2	28	18	30
120	68	6	11	30	0.2	32	18	24

IPSS –INTERNATIONAL PROSTATE SYMPTOM SCORE

QMAX- PEAK FLOW RATE –IN ML/SECONDS

PVR- POSTVOID RESIDUAL URINE –IN ML

BWT- BLADDER WALL THICKNESS –IN CENTIMETER

UEBW- ULTRASOUND ESTIMATED BLADDER WEIGHT –IN GRAMS

AG NO-ABRAHAM GRIFFITH NUMBER

PR VOL- PROSTATE VOLUME –IN CC